marked P, in fig. 13, be placed with its base *k l* to coincide with *h m*, in fig. 15, the point *i* of the pitch-board will intersect the line *a k* in the point *n*, from which let fall the perpendicular *n m*, and draw the line *m c*, which is the base of the hip or arris of the two intersecting surfaces; hence then let the line *m' c'* be the base of a plane passing vertically through this arris *m' n'*, its height over the point *m* and *n' c'* is the line of the hip; from the point *m* draw the line *x m'* at right angles to *m' c'*; and with the point *m* as a centre, describe the circle *x o*, and let fall the perpendicular *o p*; draw *r q* through the point *m* at right angles to *m c*, and draw also the lines *r p* and *p q*; and the angle which *p q* forms with the line *p r* is the bevel for the joint across the end of plank. Again, to find the direction of the end of the face-mould, as shewn by the line *h* R, in fig. 14, let fall a perpendicular from the point *x*, in fig. 15, through *s* down to the point *t*; draw the line *t v* at right angles to *a b*, until it meets the line *a e* in the point *u*; and from the point *u* draw the line *u g*, having first drawn the line *a g* perpendicular to *a e*, the length of the line *a g* being made equal to *a e*; if the triangle *a b c* is again turned up on its base, and the triangle *a g e* turned over upon the line *a e* as on a hinge, the line *a g* will coincide with the intersecting line *a c*, and the line *u g* will be the arris formed by the intersection of the surfaces of the plane of the plank, and that of the butt-joint; moreover, the point *u* would coincide with the point *x*, if turned up, and placed vertically upon its base line *m e*. Having obtained the bevel which the line *u g* forms with the line *a e* in fig. 15, let the same bevel be applied to the line A E in fig. 14, and made to pass through the point *h* in the face-mould to the point R; and the line R *h* produced across the end of the mould will be the direction of the butt-joint on the face of the plank.

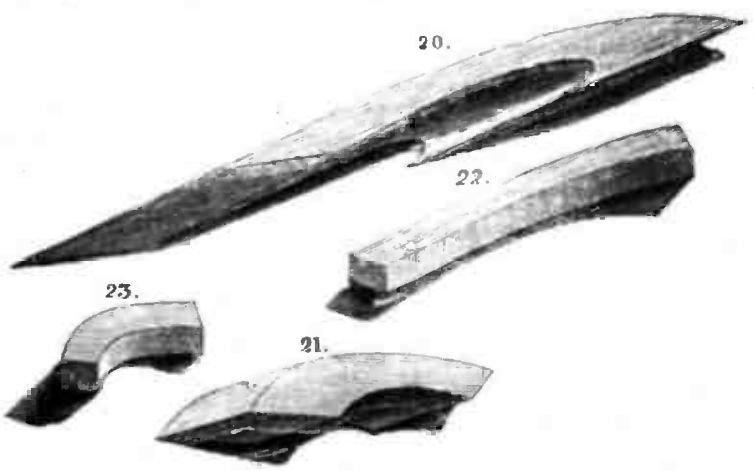
The use of fig. 16 is to explain the mode of obtaining the bevels for the butt joints at the middle of the twisted portion of the rail; it is much simpler in its details than that of fig. 15. In fig. 16, the same tribedral is taken to work upon, but instead of placing the pitch-board P upon the plane standing on the line *a h*, which ranges down the middle of the straight portion of the rail, we make use of the pitch-board O, which is applied on the plane surface standing upon the line *b c*, which is directly at right angles to the plane on the line *a g*, in fig. 15. Hence then, after having the base *a b c*, the vertical plane *a b e*, which is at right angles to the intersecting line *a c*, and the plane *b c f*, as in the former figure, begin by making *a k* in the same position as *a h* in fig. 15. Let the point *d* of the pitch-board marked O, fig 13, be applied to the point *k* on the line *b e*, fig. 16, when the slanting edge of the pitch-board will be found to intersect the line *f c*, in the point *h*; from *h* let fall the perpendicular *h i*, and draw the line *a i*, which is the base of the hip or arris of the inclined surfaces of the planes of the plank and that of the butt joint; draw any line *m' a'* parallel to *a i*, and make *a' m'* equal in length to *a i*, make the perpendicular *m l* equal to *h i*, and draw the line *a' l*, which is the line of the hip, standing immediately over its base line *a i*; from the point *k*, at right angles to *a i*, draw the line *k r*, which produce to *q*, draw the line *n q* at right angles to *a l*, and with the point *q* as a centre describe the circle *n o*; parallel to *q s*, draw the line *o p*, join *p r* and *p k*, and the angle *r p k* is the bevel for the joint across the end of the plank. Care must be taken that these bevels are applied from the upper surface of the plank when the straight end of the twist is at the lower level.

Again, to find the line forming the end of the face-mould, from the extreme end of the face-mould to the point *s*, fig 14. In fig 16, draw the line *i v* at right angles to *a b*, produce *i v* to meet the line *a e*, in the point *t*, draw also the perpendicular *t u*, cutting the line *e g* in the point *u*, join *a u*, which is the line or arris of the intersecting surfaces of the plane of the plank, and that of the butt joint. In this, as in the former figure, if the triangle *a b e* is turned up on its base *a b*, and the triangle *a g e* be made to turn over upon the line *a e*, as on a hinge, the line *a g* will coincide with the intersecting line *a c*, and the line *a u* will coincide with the hip or arris formed by the intersection of the plane of the plank with the plane of the butt-joint.

Fig. 17 shews the mode of forming the side-moulds of the jointing-box for the purpose of adjusting the vertical sides of the wreathed rail. The central line of the side mould in this figure is the same in every respect to the central line in fig. 14, and the inner and outer curves are produced by the formation of similar ellipses, by means of the trammel, as pointed out in the earlier part of this subject. The mode of obtaining the lengths of the major axes of the inner and outer ellipses are shewn by dotted lines drawn parallel to *i k*, the width from the central line to the point *l* being made equal to half the width of the hand-rail. The bevel from the point *g* shews the angle of obliquity at which the side-moulds are placed in their positions on the opposite sides of the jointing-box.

Fig. 18 shews the mode of forming the jointing-box. The block of wood, R S, in fig. 14, is here shewn on its back edge, and the sides of the box, which are curved to the contour of the side-moulds, as obtained by fig. 17, are shewn in ledgement on each side of the back of the block. This block is first formed of material planed true and adjusted to a thickness nearly the same as the thickness of the plank out of which the rail is cut; having squared the sides and edges of the block, mark off the points R and S on the line in the centre of the back-face corresponding exactly with the points R and S, in fig. 14; also mark off the point *x*, on the same line from this point *x*, square over and draw the lines *x y* and *x y* on each side of the block; with the bevel marked *p q* in fig. 15 adjust the end across the plank at the corresponding end of the rail, as marked by the line R *h'*, in fig. 14; also with the bevel *r p k*, in fig. 16, adjust the end across the plank at the other end of the rail, as shewn by the line S, taking care in bevelling the ends across the block that the length of the line R S, in the line upon the back face of the block, be kept exactly the same length as the line R S, in fig. 14. Having thus adjusted the block in the manner here described, next proceed to fix the side-moulds on the faces of the block. In the line from *q q* on the back edge of the block, and in the point on the line R S, as drawn upon this edge, let the bevel of the line A E and B E be taken and applied to the edge of the block, as shewn in fig. 18, we have thereby the obliquity at which the side-moulds are to be placed, as shewn by the points *a a*, from which draw the lines *a g* and *a g*, on both surfaces of the block; having done this, take the side-mould, as shewn by fig. 17; in applying which to the sides of the block, let the line *a q* on the side-mould be placed to correspond with the lines *a q*, as already marked off on the sides of the block; let the side-moulds thus placed be firmly screwed to the sides of the block, and the superfluous ends cut off and planed clean and true to bevelled ends of the block, as already obtained, and the jointing-block is complete.

The face-mould in fig. 14 is applied to the plank (out of which the rail is cut), on both sides of the plank directly opposite or square to each other, and the solid is cut out without any obliquity whatever; a slight allowance is made at the ends of the solid material, so as to allow for the slight bevel required in the joint. Having cut the solid out of the plank, next place it in the jointing-box, apply to the sides of the box a pair of hand-screws, and adjust the solid, so as to agree with the average line of the curved edges of the side-moulds; upon the side of the jointing-box, next proceed to adjust the inner surface of the hand-rail by means of a hollowing plane adapted to the horizontal curve of the rail, and shut the ends of each joint as in a common mitre block. Having then the inner vertical surface of the rail, and the height of the back of the hand-rail at each end in the centre of the solid, and also an intermediate height between these two ends, the twists of the rail may be joined together, and finished with ease.



Figs. 20 and 21 shew the quantity of material required in the formation of the twisted part of a handrail, for a 3-inch well-hole with seven winders, according to the theory laid down by a former writer on this subject.

Figs. 22 and 23, shew the comparative quantity of material required for the same portion of the hand-rail, by adopting the mode we have been endeavouring to describe; the thickness of plank being the same in both cases.

The saving arising not only in the economy of material, but also in the diminution of the amount of labour, is too obvious to require comment. GEORGE RIDLEY.

THE DRAINAGE OF THE ANCHOLME LEVEL.

AT the last meeting of the Institution of Civil Engineers, March 18th, a paper by Sir John Rennie on the drainage of the Ancholme level, Lincolnshire, was read. It commenced by describing the position of the Ancholme level, which consists of a low tract of land of about 200,000 acres in extent, situated on the south side of the river Humber, about 10 miles below its junction with the river Trent. The river Ancholme runs through the centre of this level, and with its tributary streams, empties itself into the Humber at the village of Ferraby. The alluvial matter brought down by these streams formed a bar at the junction of the Ancholme with the Humber, which by preventing the discharge of the drainage waters, caused the level to be inundated with water, rendering this part of the land totally unfit for tillage. The paper then, after entering into great historical detail as to the works which were executed at various periods from the time of the Romans, to render this tract of land available for agricultural purposes, stated that in the year 1801 the late Mr. Rennie being applied to for his opinion as to the best plan for improving and completing the drainage and navigation of the level, reported that he attributed its defective drainage to the deficient capacity of the Ancholme and the subsidiary drains to carry off the floods, to the sill of the old Ferraby sluice having been laid too high, and to there not being any catch-water drains to prevent the floods from the adjacent high lands descending into the level. As a remedy for these evils, he recommended that the main river, Ancholme, should be still further improved, by straightening, deepening, and enlarging its channel; and that two new locks should be placed upon it; also that, with a view to preventing the floods from the highlands inundating the level, two catch-water drains should be made, one on the east side, and the other on the west side of the river Ancholme,